CHAPTER 7

CHINA'S HIGH-TECHNOLOGY DEVELOPMENT AND U.S.-CHINA SCIENCE AND TECHNOLOGY COOPERATION

"***ECONOMIC REFORMS AND UNITED STATES ECONOMIC TRANSFERS.*** *The Commission shall analyze and assess . . . the relocation of high-technology . . . and R&D facilities; [and] the impact of these transfers on United States national security . . .*" [P.L. 108–7 Division P, Sec. 2(c)(2)(B)]

"***UNITED STATES-CHINA BILATERAL PROGRAMS.*** *The Commission shall assess science and technology programs to evaluate if the United States is developing an adequate coordinating mechanism with appropriate review by the intelligence community with Congress; [and] assess the degree of non-compliance by China and United States-China agreements on . . . intellectual property rights . . .*" [P.L. 108–7, Division P, Sec. 2(c)(2)(G)]

KEY FINDINGS

- The Chinese government has a coordinated, sustainable vision for science and technology development. Many Chinese high-technology developments have been spurred by policies the Chinese government has instituted to accelerate the growth of industries in this sector, which the government believes can help lift the whole economy.
- The Chinese government uses foreign investment, tax policies, subsidies, technology standards, and industry regulation to accelerate the nation's technological growth. It uses government procurement and proprietary technology standards to advance its technology growth policies. These policies make it difficult, if not impossible, to achieve a level playing field in this area of U.S.-China trade.
- Global production networks dominate China's high-tech export environment. Foreign investment into China has provided capital, management, and technology to Chinese production in various technology sectors. Taiwan firms are key investors and intermediaries in China's high-tech production networks.
- U.S. trade and investment with China has played, and continues to play, a key role in China's technological advancement. U.S. advanced technology and technological expertise is transferred to China, through both legal and illegal means, via U.S. invested firms and research centers in China, Chinese investments in the United States, bilateral science and technology (S&T) cooperative programs, and the tens of thousands of Chinese students and re-

searchers at U.S. universities and research institutes who return to China after completing these programs.
- Large-scale piracy—at levels of over ninety percent—continues to characterize intellectual property rights (IPR) protection in China and is a major concern for U.S. exporters of high-tech goods and services. While the government has instituted laws to strengthen IPR protection, the enforcement of those laws has suffered from a lack of government coordination and from local protectionism and corruption.

OVERVIEW

China's technology development, including its growth as a producer of high-tech goods and services and as a center for research and development (R&D) activities is a significant component of China's overall economic development that has important implications for U.S. economic and security interests. China's technology advancements are directly related to its economic engagements with the United States and other trading partners, who have shared technology via trade, investment, government-to-government cooperative programs, and research and academic exchanges.

China has become a pivotal player in the global supply chain for high-tech goods and services and continues to receive high levels of foreign direct investment (FDI) in this sector. At the same time, foreign firms are increasingly looking at China as a cost-effective locale for conducting R&D activities as well as manufacturing, given the growing numbers and sophistication of Chinese engineers and scientists. Moreover, China's technological advancements have been bolstered by U.S.-China government-to-government science and technology cooperative programs and by the large numbers of Chinese students and researchers engaged in advanced technology work at U.S. universities and research institutes. This dynamic—the U.S. role in China's technological advancement—is significant and merits monitoring and assessment, particularly where the technologies involved may have significant implications for technological competitiveness and military applications. The U.S. government has various programs and mechanisms in place to monitor and regulate these activities, namely the S&T Cooperation Agreement, the Committee on Foreign Investments in the United States (CFIUS), and export control policy in general, but the sufficiency of these programs and mechanisms remains in question. Given the trajectory of China's technology development, it is essential that the U.S. government fully understands this development and the challenges it poses for U.S. technological competitiveness and security.

On February 12–13, 2004, the Commission held a two-day field hearing, *China as an Emerging Regional and Technology Power,* to examine China's high-tech development and its implications for the Asian region and U.S. economic and security interests. During this field hearing, held on the campus of the University of California, San Diego, the Commission heard testimony from a number of scholars and representatives of California's high-tech community on the themes of China's high-tech development programs, China's role in the global supply chain for high-tech goods and services, the

impact of China's growth in this area on Asian regional economies, and appropriate U.S. policy responses to these developments.

ANALYSIS AND FINDINGS

China's Focused High-Tech Development Strategy: Modernizing the Military and Directing FDI

The Chinese government has a coordinated, sustainable vision for science and technology development. Many Chinese high-technology developments have been spurred by policies the Chinese government has instituted to accelerate the growth of industries in this sector, which the government believes can help lift the whole economy.

Since the late 1970s, China's leaders have believed that a broad-based modernization of the whole economy will sustain long-term military modernization. "During the 16th Party Congress [2002], China's leaders reaffirmed their primary commitment to economic development and their continued support for military modernization." [1] In practice, this translates into the intersection of civilian and military technological development. For example, the Chinese Academy of Sciences conducts research with various institutions on engineering, remote sensing, semiconductors, and lasers throughout China in cities with a strong defense industrial base. As a result, there is close collaboration with the military in "applied research, with products funded or developed for use by the military." [2]

The PRC launched the National High Technology Research and Development Program of China (863 Program) in March 1986. Its mission is to focus on strategic, forefront, and foresighted high technology that can benefit China's long-and medium-term development.[3] Major areas influenced by the 863 Program are biotechnology, space technology, information technology, laser technology, automation technology, energy technology, and advanced materials. The program was initially proposed by China's strategic weapons scientists, and its continued emphasis on "strategic civil and military technology development and its stated objective of achieving technological parity with the industrialized nations has made it, at times, a controversial prospect for foreign investment." [4] The R&D funding for a project under the 863 Program usually comes from various channels, including government, industry, and private entities.[5]

The 863 Program has provided a more streamlined form of funding that enables the Chinese government to target specific goals through directed R&D spending. The 863 Program funds are allocated directly to 863 experts rather than through a large bureaucratic system. Thus, the government is able to fast-track its S&T priorities. For example, space technology advancements from the relevant 863 expert committees contributed to the recent success of China's manned space program.[6] Outside of the 863 Program, official Chinese R&D funding takes place through regular S&T line items in the ministerial or state budget; block grants allocated to these entities; and through commercial fund-raising ventures established between labs and enterprises.[7]

The growth of China's domestic R&D capacity has also been bolstered by a government strategy to encourage FDI in particular areas and regions. For example, foreign computer and telecom companies established centers, programs, and labs in China, encouraged by the government's tax and other investment incentives expressly provided to entice those industries. Moreover, Chinese firms in these industries have pursued a strategy of partnering with multiple foreign firms to extrapolate the broadest array of technological capabilities from all firms involved.[8]

Foreign high-tech R&D investment in China experienced a quick transformation throughout the 1990s. From the early to mid-1990s, foreign R&D investment was best characterized as exploratory, strategic investment. During the middle of the decade, China's information technology (IT) market was opening further to foreign investment and growing increasingly competitive. In the period after China's accession into the WTO in 2001, many companies have been exploring their interests in moving up the value-added production chain and seeking a local R&D base.[9]

Dean Peter Cowhey of the University of California, San Diego, testified before the Commission that China's technological advancement currently involves a substantial pool of scientists and engineers who are focused on achieving advances in technology. When looking at China's high-tech R&D, one must take note of the speed and the depth of those advances. China thus far has demonstrated periodic spurts of technological growth in the R&D stages of development, but over the long term it will require consistent, quality growth to affect a genuine rise in the nation's technological position in the world.[10] China devotes only five percent of its R&D spending to basic research, focusing the rest on applied R&D for the purpose of immediate economic development.[11] In addition, the development of China's R&D sector is in part hindered by the state's inability to enforce IPR protection. China's failure to protect IPR has limited investment and technology transfer decisions by some foreign firms in the technology sector.[12]

Taking the pharmaceutical industry as an example, Dr. Lee Zhong of NatureGen, Inc., testified that China is the second largest pharmaceutical ingredient manufacturer and supplier in the world, but most of this production to date has been in the generic field. To produce genuine advancement in the pharmaceutical field, the Chinese pharmaceutical industry needs to expand R&D to develop its own products, increase efficiency, and develop quality control. While products manufactured by China's pharmaceutical companies have been principally generic, foreign investment and the transfers of technology and management systems that accompany this investment are accelerating the growth of a more sophisticated pharmaceutical industry. Foreign manufacturers of pharmaceuticals are beginning to establish R&D facilities in China. The United States is the second-largest investor in the China pharmaceutical industry after Hong Kong.[13]

The biotech industry in China is also growing, and the government is supporting its development. The Commission was told by one U.S. biotech industry executive that the Chinese government was supporting its biotech industry through the annual investment of more than $600 million into universities, research centers, and

labs and encouraging Chinese nationals who have obtained doctorates in the life sciences field in the United States to return to China by offering them incentives, such as associate professorships, to do so.[14]

China is also attracting R&D investment into biotechnology from Taiwan. The Commission heard testimony that while the Taiwan biotech industry is relatively strong, more investment from both the Taiwan government and the private sector is now going to the mainland. This investment, in combination with Beijing's own investment in biotech, has allowed China's biotech industry to grow upwards of thirty percent a year, and the rate is increasing, while Taiwan's biotech industry has grown about twenty-five percent annually over the last five years and is slowing down.[15]

The Chinese government plays a large role in China's high-tech development, and its technology policy utilizes standards as leverage to build the industry as a whole. Dean Cowhey testified that China has "employed proprietary technology standards to shift the terms of competition in favor of Chinese technology."[16] If foreign companies adopt Chinese-promulgated standards to get access to the growing Chinese market, they help build economies of scale, which then encourages the growth of exports out of China with these new standards. The Chinese government also uses its power over state-owned enterprises (SOE) and over companies that require licenses to produce or provide services, to organize bargaining cartels with foreign corporations to encourage technology transfers into China.[17] This use of proprietary technology standards has become a new means of coercing technology transfers, replacing the customary forced technology transfers that China agreed to end in its WTO agreement. Further discussion of forced technology transfers can be found in Chapter 2.

In addition to these concerns, high-tech investments into China have the potential to contribute to the development of militarily significant technologies.[18] China's current emphasis on information warfare in its military doctrine, discussed in greater detail in Chapter 8, makes the presence of investment in possible dual-use military technology particularly alarming.

China's Prominent Role in Global High-Tech Supply Chains

Since 1990, China's total exports have grown eightfold, to more than $380 billion in 2003, with its exports in the electronics industry accounting for thirty percent of Asia's total in that sector.[19] The share of China's exports related to high-tech goods has increased dramatically over the past decade. For example, electronics, machinery, and transport equipment have gone from 18.1 percent of China's exports in 1994 to 42.9 percent of its exports in 2003, an increase of 24.8 percent.[20] Of this amount, exports of office and data processing machines (which include computers and computer components) increased by 12.1 percent, electric appliances by 4.8 percent, and telecommunications equipment by 4.7 percent.[21] In addition, R&D performed in China by majority-owned foreign affiliates of U.S. companies in 2001 totaled $506 million (up from $7 million in 1994), making China the eleventh largest recipient of U.S.-owned foreign R&D expenditures.[22] Figure 7.1 shows the U.S. trade deficit with China in technology goods from 1991 to 2003.

Figure 7.1 U.S. Advanced Technology Products (ATP)* Trade with China

*As Defined by the U.S. Department of Commerce.[23]
Source: U.S. Census Bureau

Trade and investment flows in the Asian region have undergone a major shift in the past decade. In the 1980s and early 1990s, capital goods and components "were shipped from Japan to Asia's newly industrializing countries for processing and then exported to industrial countries. China's opening to trade has added a link in this chain. Capital goods are now shipped to Taiwan and South Korea; capital-intensive components are then sent to China and elsewhere in Asia for labor-intensive processing and assembly, before being reexported to developed markets." [24]

This new trade pattern has changed the pattern of China's imports. Whereas between 1995 and 2000, China's total imports for domestic demand almost doubled to $78.8 billion, its imports for reprocessing nearly tripled to $81.9 billion. China is now running trade deficits with eastern Asia and trade surpluses with North America and Europe. According to Chinese data, China currently has trade deficits of $31.5 billion with Taiwan, $13.1 billion with South Korea, $7.6 billion with the ASEAN, $5 billion with Japan, and $1.3 billion with Australia.[25]

Specifically in high-tech sectors Asian countries worry about losing their competitive edge to China especially in high-technology markets.[26] For example, the new trend for Japanese FDI to China is that electronics companies make high-profile investments to produce high-end consumer products. China is thus acquiring a full-set industrial structure at the expense of Japan.[27] The Commission was told that since 1998, "a third to a half of Japan's China-bound FDI was in the high-tech sector, particularly in electrical machinery and electronics." [28]

The Commission heard testimony from Jason Dedrick of the University of California's Irvine Center for Research on Information Technology and Organizations concerning the electronics manufacturing trade between the United States and China. He testified that China's growth as a world computer manufacturer did have some positive effects on the U.S. industry in the 1990s. First, by developing production networks in Asia, U.S. companies were able to compete with the Japanese. Second, U.S. companies were able to pass off low-value, low-margin manufacturing to Asia and keep higher-profit, higher-margin industries in the United States. And finally, the IT productivity boom of the late 1990s was made possible through lower-cost hardware.[29]

Taiwan and the United States are the main foreign actors that shape China's role in global trade and investment patterns in high-tech goods. The U.S. contribution to this chain has traditionally been at the front in the innovation and development of new technologies and platforms, creating and determining the technologies to be traded. Thus, the U.S.-Taiwan-China trade and investment triangle, according to testimony by Professor Barry Naughton of the University of California, San Diego, allows U.S. companies' technology products and design platforms to dominate the global arena.[30] However, the Chinese government is now taking measures that have created tensions with U.S. high-tech companies.[31] China is developing its own domestic software standards for wireless computers, introducing exclusive technology formats for cell phones and DVD players, drafting standards for radio frequency identification, and using tax policies to benefit domestic production of semiconductors.[32] This latter action is the subject of the first U.S. WTO dispute brought against China, which is discussed in Chapter 2.

Taiwan's high-tech investment into China carries unique economic and security concerns. John Tkacik testified to the Commission that

> *In a top secret report entitled, "An Analysis on how the Chinese Communist Party Attracts Taiwanese High Tech Investment for the Suzhou Industrial Park," Taiwan's intelligence agency reported in July 2001, that the Chinese authorities have a blueprint to actively develop semiconductor and high-tech industry 'clusters' which include the entire spectrum of each industry. The result, the report said, was that China has effectively attracted the key sectors of Taiwan's computer industry, from downstream component makers like computer motherboard and monitor producers to PC cases and mouse makers. The report suggested that the Taiwan-invested high-tech sector would be a virtual 'puppet' of Beijing and recommended that the Taiwan government adopt policies to curb high-tech investment in China. Indeed, the one high-tech area in China which Taiwan's government still prohibits local investors from investing is semiconductor fabrication, but that ban, too, appears to be eroding.*[33]

A recent report on Taiwan's semiconductor industry issued by the U.S.-Taiwan Business Council detailed the challenges China poses for Taiwan's industry. According to the report, more and

more integrated circuit design firms are now choosing to have their chips fabricated in China rather than Taiwan in order to avoid the extra cost.[34] Taiwan government policies to curb the relocation of high-tech manufacturing to China have failed.[35]

In addition, the U.S. national security establishment is concerned over competition with China's high-tech industry, specifically its semiconductor industry, and by China's attraction as a low-cost, high-tech manufacturing center. As an example of this concern, the U.S. Department of Defense and the National Security Agency have "partnered with IBM to ensure on-shore manufacturing of critical semiconductor products over the next ten years …. There is a very significant concern within the Department of Defense and the national security community generally about the erosion of U.S. domestic production and the growth in Chinese domestic production." [36]

In these global supply trends, the United States presently tends to perform the most complex manufacturing, while more routine manufacturing is parceled out for lower-cost overseas production. While there is insufficient data at the moment to make an empirical case that the United States is in danger of losing its high-tech manufacturing sector to overseas competition,[37] some alarming trends in R&D deserve greater attention.

The U.S. ability to be an R&D leader and maintain an innovative edge is based on the national pool of intellectual capital. In 2002, five percent, or 59,000, of all bachelor degrees awarded in the United States were engineering degrees. By comparison, thirty-nine percent, or 219,000, of China's bachelor degrees awarded were in engineering.[38] Total graduate engineering enrollment in the United States in 2002 was 109,506, of whom 51,910 were foreign students.[39] While the United States has not yet lost its superiority in innovation, many believe that it must put a new focus on enhancing its pool of intellectual capital, or it will lose its competitive edge within a generation.[40]

Ineffective Intellectual Property Rights Protection

The International Intellectual Property Alliance (IIPA) reported in September 2003 that IPR abuses in China continue unabated. In 2002, the piracy levels remained at ninety percent or above, translating to a $1.8 billion loss to the pirated industries, according to IIPA.[41]

Three major technology product sectors largely susceptible to this lack of adequate IPR protection are the optical media, Internet, and business software technologies. Optical media plants produce pirated CDs, VCDs, and DVDs at a rampant pace. According to the Motion Picture Association of America, 95 percent of the video discs in China are pirated.[42] Web sites devoted to pirated MP3 files are on the rise, particularly among the young consumer base. And the business software industry suffers from unauthorized copying from companies and even government entities.[43] Figure 7.2 shows the estimated U.S. trade losses due to Chinese piracy in 2001–03.

Figure 7.2 Estimated Trade Losses Due to Piracy in China, 2001–2003

(millions of U.S. dollars)

Industry	2003	2002	2001
Business software applications	NA	$1,637.3	$1140.2
Entertainment software	568.2	NA	455.0
Records & music	286.0	48.0	47.0
Motion pictures	178.0	168.0	160.0

Source: IIPA, "2004 Special 301: People's Republic of China," (Washington, DC: IIPA, 2004).

The WTO's Council for Trade-related Aspects of Intellectual Property Rights (TRIPS Council) has found that while China has approved new laws to improve its IPR protections, such as amendments to the Patent Law Implementing Measures, Rules on the Determination and Protection of Well-Known Trademarks, and the drafting of revisions to the 2001 Internet-related implementing rules, enforcement is lacking.[44] In particular, the Chinese government suffers from a lack of "coordination among Chinese government ministries and agencies, local protectionism and corruption, high thresholds for criminal prosecution, lack of training and weak punishments."[45] A further discussion of TRIPS and IPR as it relates to the WTO can be found in Chapter 2.

Acquisitions of U.S. Technology

U.S. technology and expertise have been transferred to China through a variety of channels: U.S. firms' investment and joint venture projects in China, including R&D projects; Chinese firms' investments in the United States; cooperative exchange programs between U.S. and Chinese scientists and engineers; and education and employment opportunities for Chinese nationals in U.S. universities and research institutes. The Commission is concerned that as China's economic power expands, its ability to acquire advanced U.S. technology and production facilities will increase exponentially. There is a need for the U.S. government to monitor these technology transfers in a more comprehensive and coordinated manner.

The S&T Agreement

The U.S. government entered into a formal government-to-government S&T cooperative program with China beginning in 1979. Under the U.S.-China Agreement on Cooperation in Science and Technology, the two countries have conducted numerous collaborative projects under the auspices of eleven federal agencies and branches. The agreement covers diverse fields such as basic research in physics, energy-related projects, civil industrial technology, and digital mapping. In a 2002 report to Congress on these programs, the Department of State concluded that the majority of programs under the agreement have been in the "benign civilian domain" and that "while it is possible that there may have been some bleed-over into the military sphere, such unintended side effect is difficult to document or substantiate."[46] A chart of U.S.-

China active protocols, agreements, memoranda of understanding, and annexes operative from 1997 to 2001 is in appendix A.

In its 2002 Report, the Commission noted that there was "no centralized mechanism for coordinating, funding or reporting to Congress on the various cooperative programs occurring" between government agencies and Chinese entities.[47] Accordingly, the Commission recommended in its 2002 Report that the State Department conduct these reviews biennially. Congress approved this recommendation, and it is incorporated in P.L. 107–314 (sec. 1207). The reporting requirement includes an accounting of all activities conducted under the agreement and a projection of activities to be undertaken under the agreement during the next two years; a determination by the Secretary of Defense, in consultation with the director of Central Intelligence, of the extent to which the activities conducted under the agreement have enhanced the military and defense industrial base of the PRC and an assessment of the effect that projected activities under the agreement could have on the PRC's economic and military capabilities; and a determination by the inspector general of the extent to which activities under the agreement provide access to technology, information, or expertise that could enhance the PRC's military capabilities; and the extent to which activities under the agreement comply with U.S. export control laws. The law also directs the president to establish an interagency working group to oversee implementation of the agreement.

The first report under this legislation was due April 1, 2004. As of the writing of the Commission's Report, the Department of State had yet to issue its 2004 Report. The Commission intends to closely review and evaluate the findings of this report and recommend, where appropriate, legislative action to address identified problems.

Investment in the United States and CFIUS

The United States has in place export control laws designed to protect transfers of designated technologies critical to U.S. national security. Additionally, a process implemented through the interagency Committee on Foreign Investment in the United States (CFIUS) is an important tool to ensure that while the United States maintains an open investment climate, U.S. technology critical to national security is not lost through foreign acquisitions of U.S. companies.

In 1988, Congress provided the CFIUS with the authority to review, investigate, and block potential threats to U.S. national security resulting from foreign acquisitions of U.S. companies. Foreign entities voluntarily report such acquisitions because, once reviewed, they are given "safe harbor." However, those not reported are forever subject to a government-ordered divestiture should national security concerns surface. Unknown, however, is whether certain acquisitions may either go unnoticed or fall outside existing criteria but still pose security issues for the United States.

Given the increasingly open trading relationship between the United States and China, and the impact of China's investments in the United States, the Commission is concerned over the adequacy of CFIUS's reach. Are the current criteria used in the CFIUS proc-

ess to evaluate technology transfers and their potential impact on national security adequate? Are enhanced monitoring procedures needed? The CFIUS review focuses solely on traditional national security concerns with investments, while failing to consider U.S. economic security interests.

The Commission is planning future research and hearings into the security dimensions of China's acquisitions by various means of U.S. advanced technology, including an assessment of the adequacy of interagency coordination and consultation on this issue through CFIUS and other interagency structures. As part of this examination, the Commission intends to assess whether current standards for determining security concerns are sufficient.

RECOMMENDATIONS

- The U.S. government must develop a coordinated, comprehensive national policy and strategy designed to meet China's challenge to the maintenance of our scientific and technological leadership. America's economic competitiveness, standard of living, and national security are dependent on such leadership. The Commission therefore recommends that Congress charge the administration to develop and publish such a strategy in the same way it is presently required to develop and publish a national security strategy that deals with our military and political challenges around the world. In developing this strategy, the administration should utilize data presently compiled by the Department of Commerce to track our nation's technological competitiveness in comparison with other countries.
- The Commission recommends that Congress revise the law governing the CFIUS process (Title VII of the Defense Production Act)—which gives the president authority to investigate mergers, acquisitions, or takeovers of U.S. firms by foreign persons if such activities pose a threat to national security—to expand the definition of national security to include the potential impact on national economic security as a criterion to be reviewed. In this regard, the term national economic security should be defined broadly without limitation to particular industries.
- The Commission recommends that Congress direct the administration to transfer chairmanship of CFIUS from the Secretary of the Treasury to the Secretary of Commerce.

Appendix A

U.S.-China Active Protocols, Agreements, Memoranda of Understanding (MOU), and Annexes Operative from 1997 to 2001

Agency	Protocol, Agreement or MOU	Annex
Department of Energy	High Energy Physics Implementing Accord	
	Protocol on Nuclear Physics and Controlled Magnetic Fusion Research	
	Protocol for Cooperation in the Fields of Energy Efficiency and Renewable Energy Technology Development and Utilization	• Annex I: Rural Energy Development • Annex II: Wind Energy Development • Annex III: Energy Efficiency • Annex IV: Renewable Energy Business Development • Annex V: Exploratory Research for Advanced Batteries and Ultracapacitors • Annex VI: Geothermal Production and Use • Annex VII: Renewable Energy Policy and Planning
	Fossil Energy Protocol	• Project Annex I: Cooperation in the Area of Power Systems • Project Annex II: Cooperation in the Area of Clean Fuels (not yet signed) • Project Annex III: in the Areas of Oil and Gas • Project Annex IV: Cooperation in the Areas of Environmental Technologies • Project Annex V: Climate Science
	Agreement on Peaceful Uses of Nuclear Technologies	
	Protocol on Exchange of Energy Information	
	The U.S.-China Energy and Environment Technology Center	
Department of the Interior *Minerals Management Service*	Memorandum of Understanding on Mineral Resource Management Information Sharing	

Appendix A—Continued

U.S.-China Active Protocols, Agreements, Memoranda of Understanding (MOU), and Annexes Operative from 1997 to 2001

Agency	Protocol, Agreement or MOU	Annex
Fish and Wildlife Service	The Protocol on Cooperation and Exchanges in the Field of Conservation of Nature	Memorandum of Understanding on Water Resources Management and Conservation
Bureau of Reclamation *U.S. Geological Survey*	Earth Sciences Protocol	• Annex I: Sediment-Hosted Gold Deposits of the United States and China • Annex II: Collaborative Studies of the Major Mineral Deposits, Metallogenesis, and Tectonics of Northeast China • Annex III: Collaborative Studies of the Human Health Impacts of Domestic Coal Use in China and the United States
	The Earthquake Studies Protocol	• Annex I: Investigations of Premonitory and Phenomena and Techniques for Earthquake Prediction • Annex II: Investigation of Intra-plate Active Faults and Earthquakes • Annex III: Cooperative Research on Earthquake Engineering and Hazards Mitigation • Annex IV: Cooperative Research Projects on Deep Crustal Structure • Annex X: Cooperative Research Projects on Laboratory Studies in Rock Mechanics • Annex XI: Deployment of Very Long Period Seismograph Stations and Cooperative Research • Annex XII: Exchange of Data and Films of Seismograms
	The Protocol for Scientific and Technical Cooperation in Surveying and Mapping Studies	• Project Annex I: Scientific and Technical Cooperation in Surveying and Mapping Studies Concerning Developing Geographic Information Systems • Project Annex II: Surveying and Mapping Studies in the Application of Remote Sensing Information

Appendix A—Continued

U.S.-China Active Protocols, Agreements, Memoranda of Understanding (MOU), and Annexes Operative from 1997 to 2001

Agency	Protocol, Agreement or MOU	Annex
		• Project Annex IV: Scientific and Technical Cooperation in the Application of Geodetic and Geophysical Data to Mapping, Charting, and Geodetic Programs
U.S. Geological Survey	The Surface-Water Hydrology Protocol	• Project Annex I: Interchange of Scientific and Technical Information on Hydrology and Analytical Techniques of Water Resources Study • Project Annex II: Hydrologic Measurement Procedures, Instruments, and Equipment • Project Annex IV: Cooperative Project on Sediment Transport • Project Annex XI: Cold Regions Hydrology • Project Annex XII: Water Quality
Department of Commerce *National Oceanic and Atmospheric Administration*	Protocol on Cooperation in the Field of Marine and Fisheries Science and Technology	
	Protocol on Cooperation in the Field of Atmospheric Science and Technology	
Technology Administration	Protocol on Cooperation in Civil Industrial Technology and Scientific and Technical Information	• Annex II: Cooperation in Civil Industrial Technology
Department of Agriculture	Understanding on Agricultural Exchange	
Foreign Agricultural Service	Joint Operating Agreement on Biological Control	
Agricultural Research Service *U.S. Forest Service*	Memorandum of Understanding on Forestry Cooperation	
Nuclear Regulatory Commission	Protocol on Cooperation in Nuclear Safety Matter	

Appendix A—Continued

U.S.-China Active Protocols, Agreements, Memoranda of Understanding (MOU), and Annexes Operative from 1997 to 2001

Agency	Protocol, Agreement or MOU	Annex
National Science Foundation	The Basic Science Protocol	
	The Earthquake Studies Protocol	
	Memorandum of Understanding on Ocean Drilling	
Department of Health and Human Services	Memorandum of Understanding on AIDS	
National Institutes of Health	Memorandum of Understanding on Cooperation in the Basic Biomedical Sciences	

Source: U.S. Department of State, "U.S.-China Science & Technology Cooperation" (Washington, DC: Department of State).

ENDNOTES

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2. Ibid, p. 41.
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7. Ibid, p. 166.
8. Walsh, *Foreign High-Tech R&D in China,* p. 77.
9. Ibid, p. 88.
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11. National Science Board, "Science and Engineering Indicators—2004" (Arlington, VA: National Science Foundation, 2004) p. 4–63.
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13. U.S.-China Economic and Security Review Commission, *Hearing on China as an Emerging Regional and Technology Power,* testimony of Lee Zhong, February 12–13, 2004, p. 99.
14. U.S.-China Economic and Security Review Commission, *Hearing on China as an Emerging Regional and Technology Power,* testimony of Greg Lucier, February 12–13, 2004, p. 126.
15. Ibid.

16. U.S.-China Economic and Security Review Commission, *Hearing on China as an Emerging Regional and Technological Power,* testimony of Peter Cowhey, February 12–13, 2004, p. 15.
17. Ibid.
18. Walsh, *Foreign High-Tech R&D in China,* p. 77.
19. David and Lyric Hughes Hale, "China Takes Off," *Foreign Affairs* (November/December 2003): p. 36.
20. Economic Policy Institute Snapshot for March 29, 2004, citing J.P. Morgan, "Daily Economic Briefing," March 16, 2004.
21. Ibid.
22. National Science Board, "Science and Engineering Indicators—2004," pp. 4–69.
23. The ten categories of advanced technology products are biotechnology; life sciences; opto-electronics; information and communications; electronics; flexible manufacturing; advanced materials; aerospace; weapons; and nuclear technology.
24. Hale, "China Takes Off," p. 46
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